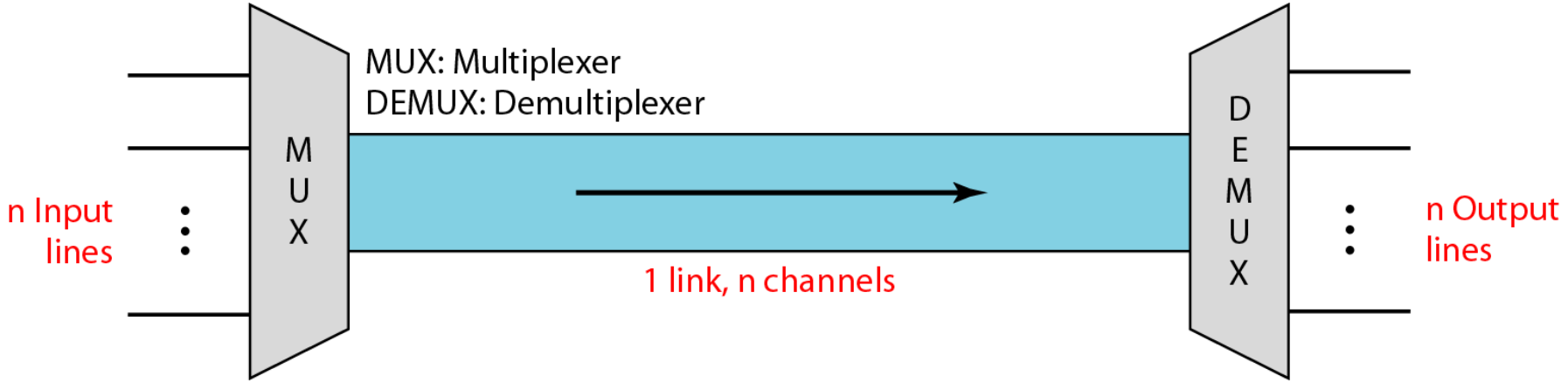
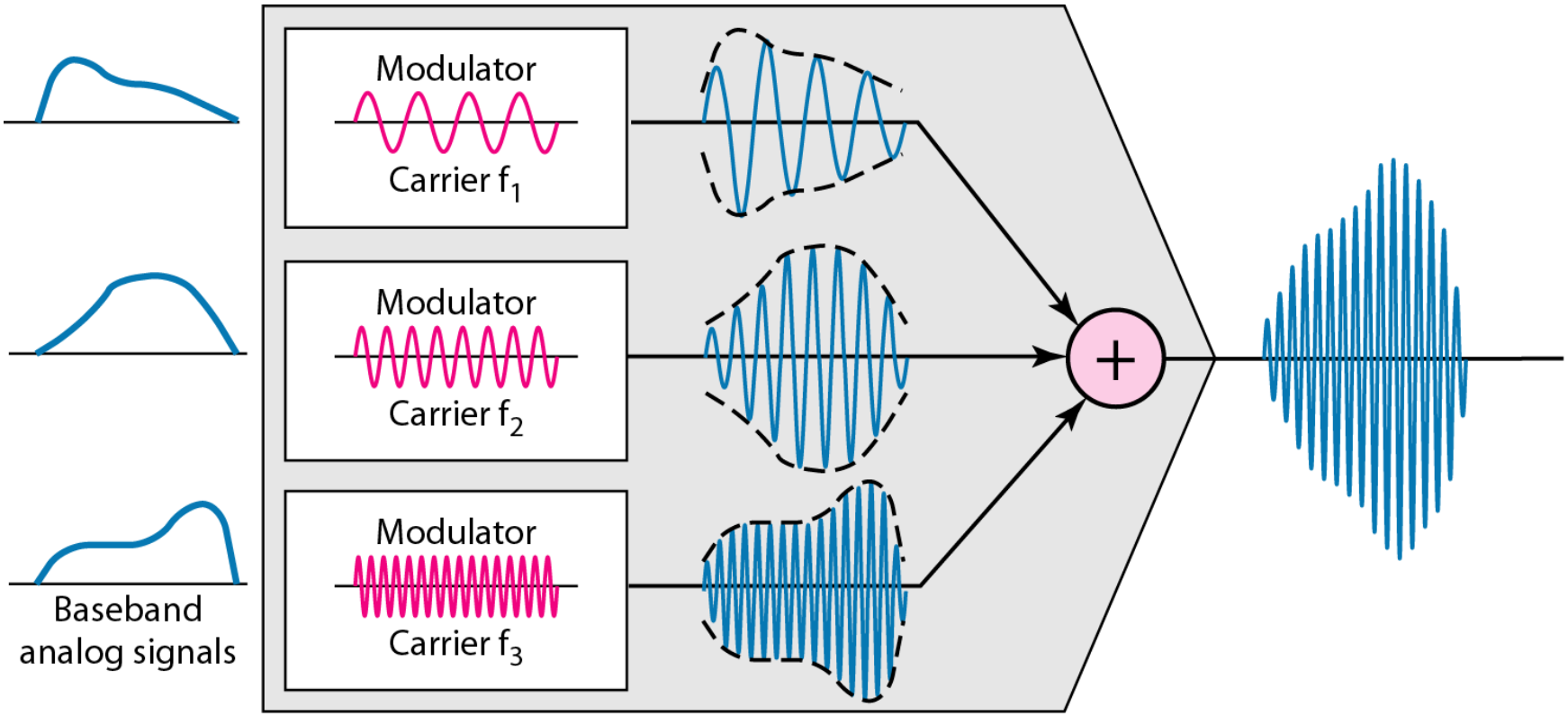
MULTIPLEXING

Multiplexing is a technique that allows the (simultaneous) of multiple independent signals can be combined into a composite signal transmitted over a common channel. As voice signals transmitted over telephone systems (range 300-to-3400 Hz).

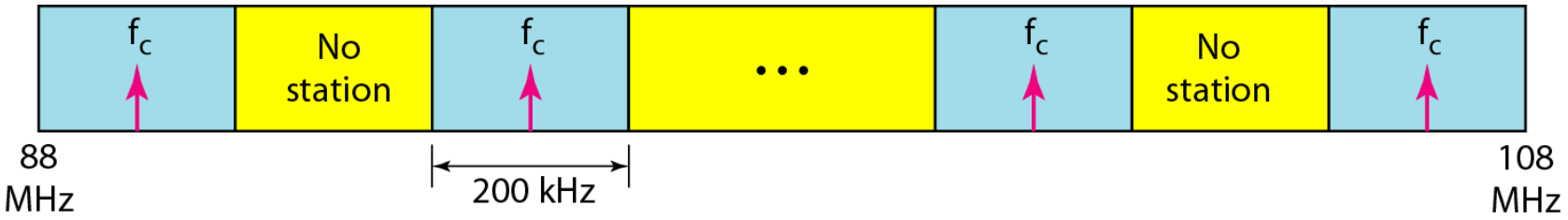
- Frequency-Division Multiplexing (FDM)
- Time-Division Multiplexing (TDM)


MUX: Multiplexer
DEMUX: Demultiplexer
n Input lines
M U X
1 link, n channels
D E M U X
n Output lines

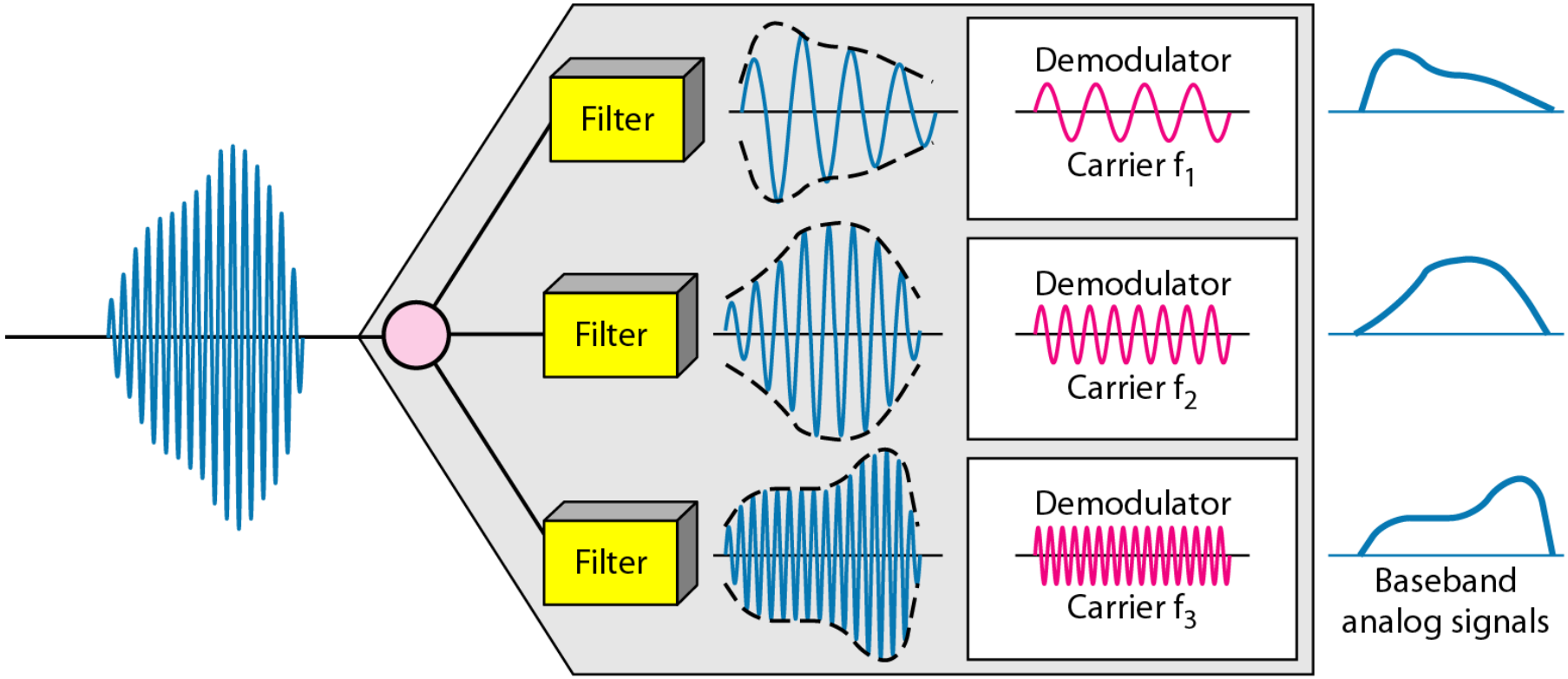
FDM process


Modulator
Carrier f_1
Modulator
Carrier f_2
Modulator
Carrier f_3
+
Baseband
analog signals

FM



FDM demultiplexing example

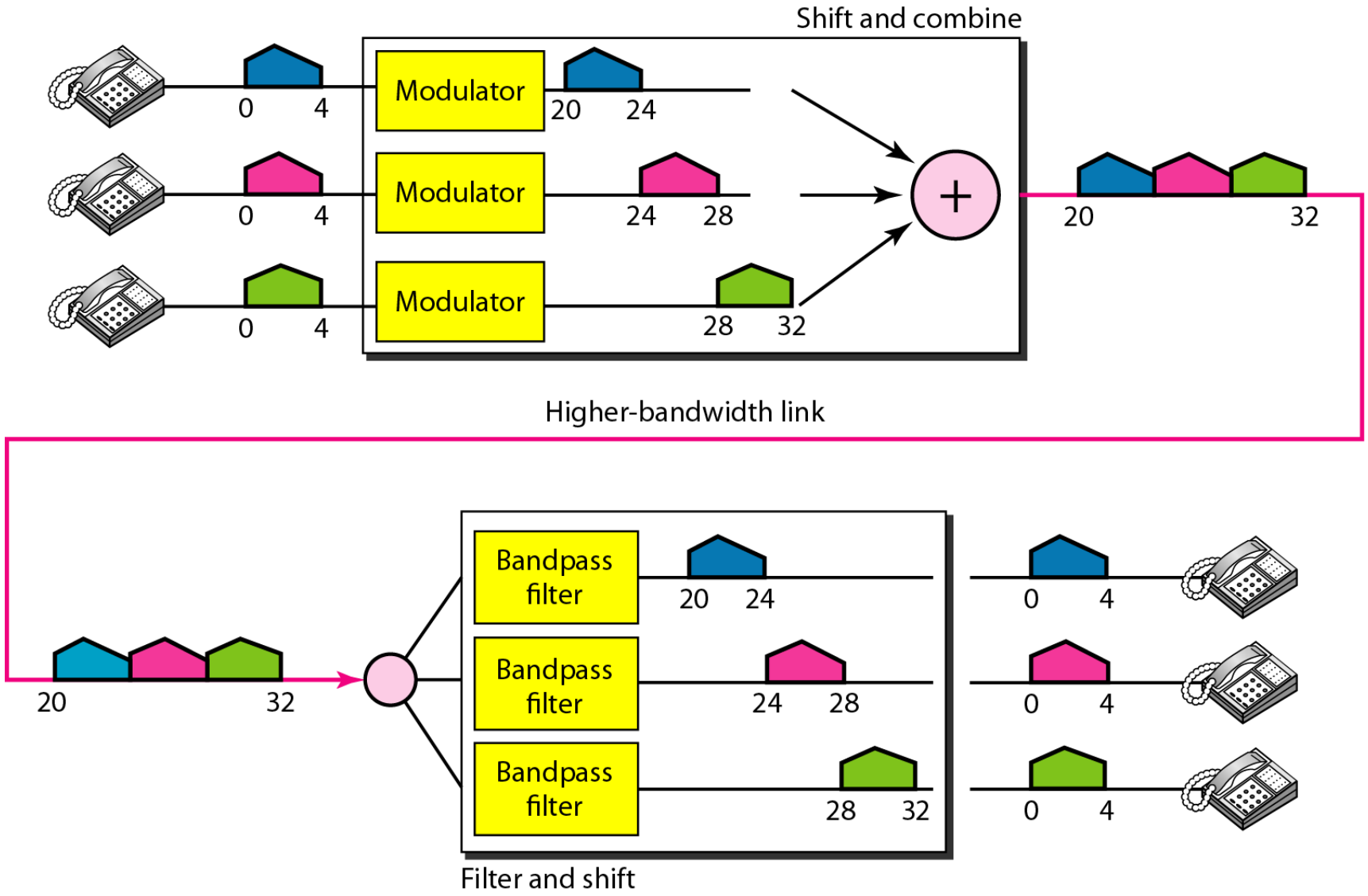


Assume that a voice channel occupies a bandwidth of 4 kHz. We need to combine three voice channels into a link with a bandwidth of 12 kHz, from 20 to 32 kHz. Show the configuration, using the frequency domain. Assume there are no guard bands.

Solution

We shift (modulate) each of the three voice channels to a different bandwidth, as shown in Figure below. We use the 20- to 24-kHz bandwidth for the first channel, the 24- to 28-kHz bandwidth for the second channel, and the 28- to 32-kHz bandwidth for the third one. Then we combine them as shown in the figure .

Example 1


Shift and combine
Modulator
Modulator
Modulator
0
4
20
24
24
28
28
32
20
32
Higher-bandwidth link
Bandpass filter
Bandpass filter
Bandpass filter
Filter and shift

Example 2

Five channels, each with a 100-kHz bandwidth, are to be multiplexed together. What is the minimum bandwidth of the link if there is a need for a guard band of 10 kHz between the channels to prevent interference?

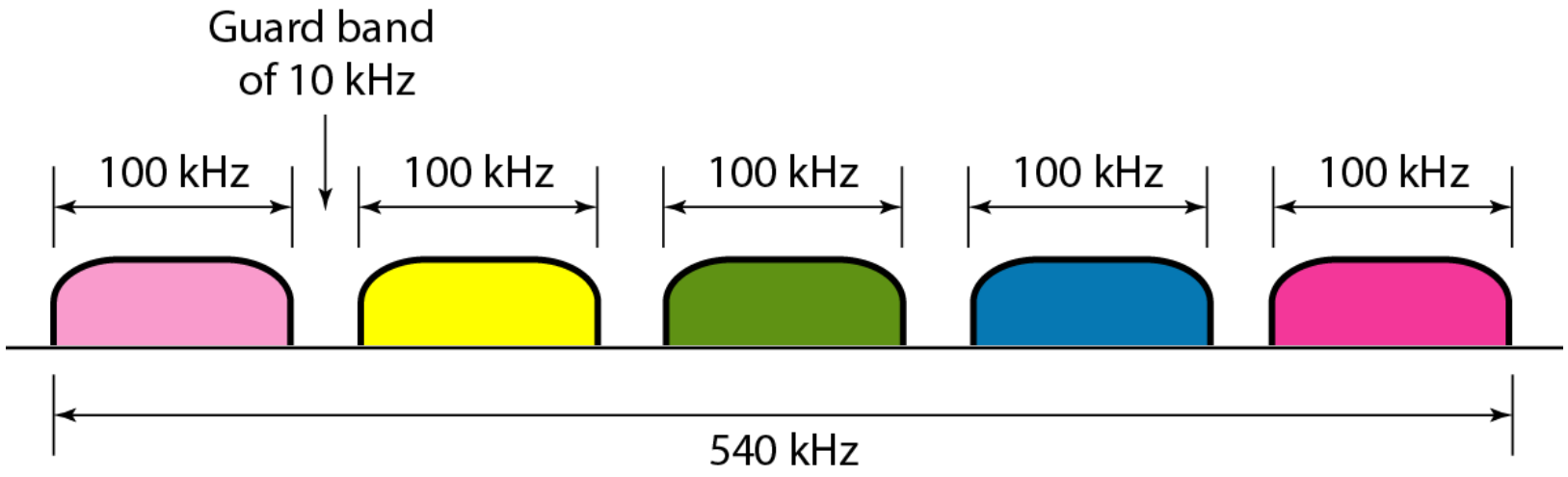
Solution

For five channels, we need at least four guard bands. This means that the required bandwidth is at least

$$5 \times 100 + 4 \times 10 = 540 \text{ kHz},$$

as shown in Figure below.

Example 2


Guard band
of 10 kHz
100 kHz
100 kHz
100 kHz
100 kHz
100 kHz
540 kHz